AN F1 HYBRID BETWEEN *EUCALYPTUS PULVERULENTA* AND *E. CAESIA*.

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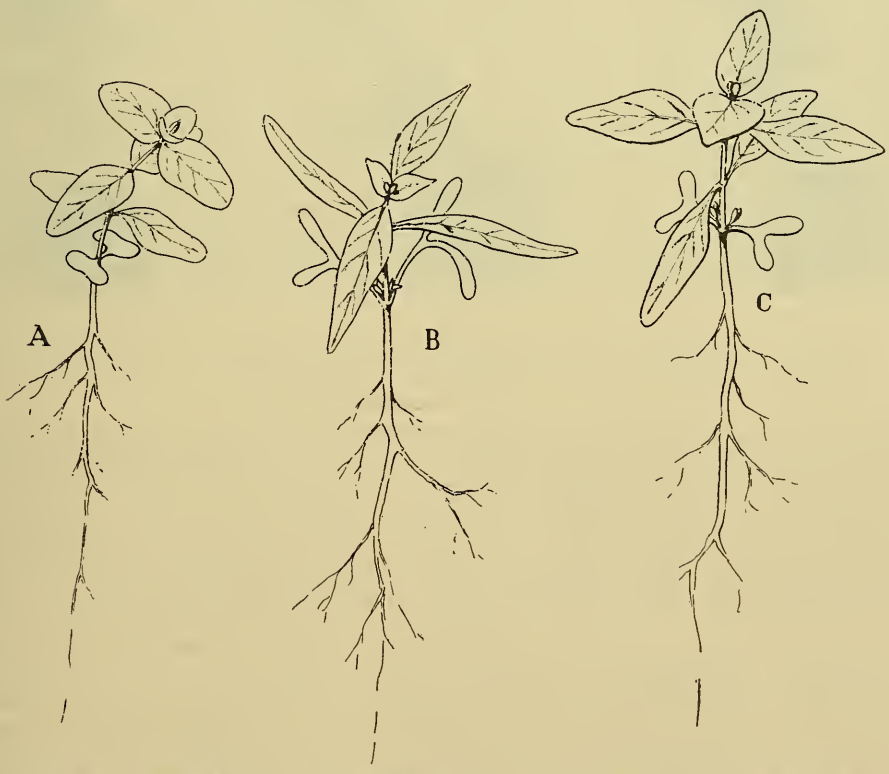
(Two Text-figures.)

[Read 30th May, 1956.]

Synopsis.

A viable F1 hybrid between *E. pulverulenta* and *E. caesia* has been produced by manipulated pollination. It is suggested that *E. caesia* belongs to a natural systematic group with bisected cotyledons and that successful hybridization between this group and many species of the Macrantherae-Normales may be possible.

Species which can cross often produce hybrids naturally when they grow near one another. Where they are always widely separated in the field it is necessary to make manipulated crossings to see whether they can hybridize. The capacity to cross is one index (though by no means the only one) of affinity between species (Duffield, 1952).



Text-fig. 1.—Seedlings of (*a*) *E. pulverulenta*, (*b*) *E. caesia* and (*c*) *E. caesia* × *E. pulverulenta* at about five months.

Where each of the pair of species involved in successful crossing is derived from separate systematic groups an indication is given of the affinity of the groups and this in turn makes possible a reasonable forecast as to which species combinations may be successful in a breeding programme.

The combination, *E. pulverulenta* and *E. caesia*,* is of this kind. *E. pulverulenta* belongs to the group Macrantherae-Normales. It has a fairly wide overall distribution between Sydney and the Victorian border. It occurs nevertheless in very small separated stands on the mountain ranges. It retains opposite, orbicular, sessile, glaucous leaves to maturity and does not develop the lanceolate, petiolate, alternate leaves characteristic of most Eucalyptus species. *E. caesia* is a species of Western Australia which Blakely places in the series Obliquae. It has the common Eucalyptus type of mature foliage. The two species are separated in their natural occurrences by some 2,000 miles.

E. pulverulenta grows easily in Canberra, as it is fully frost-hardy and reasonably drought-resistant. *E. caesia*, however, usually fails because it is too frost-sensitive. Fortunately, as a result of more than usual care and attention, Mr. A. D. Helms was able to raise a tree of this latter species to the flowering stage in his garden in Canberra, and he made this available for experiment. *E. caesia* has a relatively short flowering

a *c* *b*

Text-fig. 2.—Seedlings of (*a*) *E. pulverulenta*, (*b*) *E. caesia* and (*c*) *E. pulverulenta* × *E. caesia* at about 2 months, showing especially the cotyledon shape.

period and *E. pulverulenta* a long flowering period, which usually commences at about the end of winter and goes on for about three months. *E. caesia* flowered during the middle of this period. Reciprocal pollinations were made, but with *E. caesia* as the female parent there was complete failure with *E. pulverulenta* (and with several other species), the only flowers which set seed being selfings. However, this indicated that the individual was fully self-compatible. On the other hand, with *E. pulverulenta* as the female parent a good setting was obtained on some 20 flowers and sufficient viable seed was produced to raise about 15 seedlings. The seedlings have now produced the eighth pair of leaves and the F1 hybrids are intermediate between the two parents (Text-fig. 1) in approximately the same way that the F1s, *E. cinerea* × *E. robusta*, are intermediate between the parents (Pryor, 1954). The juvenile leaves of *E. pulverulenta* are, like the adult leaves, glaucous, orbicular, sessile and opposite, whereas those of *E. caesia* are petiolate, alternate, ovate-lanceolate and non-glaucous. The F1s of this combination are intermediate in leaf shape and glaucousness and the leaves shortly petiolate and opposite. They are, at this seedling stage, as vigorous as the faster growing parent, *E. pulverulenta*.

An interesting morphological feature is found in the cotyledons. Those of *E. pulverulenta* are of the shape characteristic of the Macrantherae-Normales, that is

* Nomenclature as in Blakely's "Key to the Eucalypts", 1934.

more or less transversely oblong and slightly emarginate. On the other hand, those of *E. caesia* are of a very distinct shape, being markedly bisected to form two slender lobes so that the whole cotyledon has the shape of the letter Y. This type of cotyledon is common in many Western Australian species but is confined to four or five only in eastern Australia. The F1 hybrid is intermediate between the two in this respect, as shown in Text-figure 2.

Discussion.

The failure of the reciprocal cross is comparable with the experience of Brett (1949) in attempting to synthesize the hybrid *E. globulus* × *E. viminalis*, where there was failure with *E. globulus* as the female parent. The suggestion made to account for this was that, since the style length is so much greater in *E. globulus* than in *E. viminalis*, this made it impossible for the tube of germinating *E. viminalis* pollen to fertilize the *E. globulus*. In the present case *E. caesia* has a style very much longer (about two to three times) than *E. pulverulenta*. It may be that this difference is the cause of failure. There may, of course, be other explanations, but this is the simplest and could well be the reason for lack of seed setting.

The successful crossing of the two species is also of consequence for other reasons. The species with bisected cotyledons have special interest. In Blakely's system of classification, many of these species are grouped, but others are dispersed through different groups. This is partly a consequence of the exclusive use of anther shape in erecting the major subdivisions in the classification. The dispersal of some of the species with bisected cotyledons leads to a number of marked anomalies. For example, *E. Kruseana* is placed in the subseries Isophyllae with *E. cordata* and *E. pulverulenta*, but apart from the opposite, sessile, glaucous leaves, which are persistent to the mature state, it has little in common with the other two species. *E. Kruseana* has bisected cotyledons which are quite unlike those of its two companions in Blakely's scheme. The same is true of *E. decipiens*, which is placed by Blakely in the series Subbuxeales. This species has, however, little affinity with the other species in this group which are mostly eastern Australian, and it also differs distinctly from all of them in having bisected cotyledons. On the basis of anther shape also, the two species, *E. salubris* and *E. campaspe*, are widely separated in Blakely's scheme of classification, the former being placed in the Section Platyantherae and the latter in the Macrantherae. But these two species have much in common, including bisected cotyledons, and placing them closely together seems a more natural arrangement than the separation, as Blakely has done. The differences in anther shape are actually small in this case.

There are several other examples of anomalies if assessed on this basis and it seems that a natural major group would be erected by placing together all the species which have bisected cotyledons, and adding them to those series such as the Cornutae and Subcornutae which already have the bisected cotyledons as a common distinguishing feature. If this proposal is sound, then *E. caesia* is a representative of a natural group of about 60 species, most of which are confined to Western Australia, which might conveniently be called the "Bisectae". The successful production of an F1 hybrid with it and *E. pulverulenta* then suggests, on the grounds of "crossability", that it has about the same relationship to the Macrantherae-Normales as has the series Transversae and the series Exsertae.

If, then, the hybrid under discussion can be taken to indicate possibilities in crossing, there is a wide range of species available for hybridizing. These may give great practical benefits. For example, many of the species with bisected cotyledons are very drought-resistant or are tolerant to either salty, swampy or calcareous soils. Many of them also have highly decorative coloured flowers. There is then a chance of bringing them together in hybrid combination with several tall growing, good timber-producing trees of the Macrantherae-Normales group, most of which are, for *Eucalyptus*, extremely frost-resistant. Most of such combinations cannot occur naturally because the great majority of the species in the two groups are very widely separated geographically. More experiment will be necessary, of course, to determine how far this generalization is correct.

There is also one field occurrence of a natural hybrid which supports the idea that the "Bisectae" may cross with the series Exsertae. This is between *E. cladocalyx* and *E. camaldulensis* at Wirrabara in South Australia. Two suspected hybrids of this combination were seen in the field by Mr. C. D. Boomsma and during a subsequent inspection in company with him seed was collected from them. The progeny, though small, shows distinct segregation as would be expected from a hybrid of the supposed parentage. There is little doubt that *E. cladocalyx* belongs to the group with bisected cotyledons (although the form of the cotyledon is not so extremely bisected as in many of the species with this character), and that its affinity is with the Western Australian species. *E. camaldulensis* is distinctly one of the species of the Exsertae.

The hybrid *E. pulverulenta* × *E. caesia* could itself be a valuable ornamental plant, as *E. caesia* has very attractive, large, bright pink flowers and *E. pulverulenta* has decorative silvery foliage.

The prospect of combining species such as the very lime-tolerant *E. gomphocephala* with frost-resistant species such as *E. bicostata* or *E. Gunnii*, or the salt-resistant *E. occidentalis* with such species, or even drought-resistant mallee species such as *E. oleosa* with these, are examples of the situation which a programme of investigation could elucidate. These speculations must be put to experimental test if they are to be verified.

References.

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